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REPORT OF SURVEY CONDUCTED AT

NAVAL AVIATION DEPOT
NORTH ISLAND
SAN DIEGO, CA

OCTOBER 1998

Best Manufacturing Practices

1998 Award Winner

INNOVATIONS IN AMERICAN GOVERNMENT

BEST MANUFACTURING PRACTICES CENTER OF EXCELLENCE
College Park, Maryland
www.bmpcoe.org

Foreword

This report was produced by the Office of Naval Research's Best Manufacturing Practices (BMP) program, a unique industry and government cooperative technology transfer effort that improves the competitiveness of America's industrial base both here and abroad. Our main goal at BMP is to increase the quality, reliability, and maintainability of goods produced by American firms. The primary objective toward this goal is simple: to identify best practices, document them, and then encourage industry and government to share information about them.

The BMP program set out in 1985 to help businesses by identifying, researching, and promoting exceptional manufacturing practices, methods, and procedures in design, test, production, facilities, logistics, and management – all areas which are highlighted in the Department of Defense's 4245.7-M, *Transition from Development to Production* manual. By fostering the sharing of information across industry lines, BMP has become a resource in helping companies identify their weak areas and examine how other companies have improved similar situations. This sharing of ideas allows companies to learn from others' attempts and to avoid costly and time-consuming duplication.

BMP identifies and documents best practices by conducting in-depth, voluntary surveys such as this one at the Naval Aviation Depot (NADEP) North Island, San Diego, California conducted during the week of October 5, 1998. Teams of BMP experts work hand-in-hand on-site with the company to examine existing practices, uncover best practices, and identify areas for even better practices.

The final survey report, which details the findings, is distributed electronically and in hard copy to thousands of representatives from industry, government, and academia throughout the U.S. and Canada – *so the knowledge can be shared.* BMP also distributes this information through several interactive services which include CD-ROMs, BMPnet, and a World Wide Web Home Page located on the Internet at http://www.bmpcoe.org. The actual exchange of detailed data is between companies at their discretion.

NADEP North Island is recognized throughout the world as an innovator in depot support. As it faces new changes, challenges, and opportunities, the Depot's pioneering spirit and commitment to excellence will enable it to remain at the forefront of technology and guide it into the next century. Among the best examples were the NADEP North Island's accomplishments in engineering development and structural analysis training program; consolidated control centers; plastic media blasting; and F/A-18 center barrel replacement.

The Best Manufacturing Practices program is committed to strengthening the U.S. industrial base. Survey findings in reports such as this one at the Naval Aviation Depot North Island expand BMP's contribution toward its goal of a stronger, more competitive, globally-minded, and environmentally-conscious American industrial program.

I encourage your participation and use of this unique resource.

Ernie Renner
Director, Best Manufacturing Practices

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Section 1

Report Summary

Background

Seven years after the Wright brothers' historic flight, a Curtiss airplane landed off the coast of California on North Island. That same year, 1910, marked the start of Naval aviation when U.S. Navy Lieutenant Theodore Ellyson transferred to North Island to receive flight instruction from the Curtiss Aviation Camp. The history of the Naval Aviation Depot (NADEP) North Island covers almost the entire lifespan of Naval aviation. The Depot began as the Assembly and Repair Department of the Naval Air Station in 1919; became a separate command known as the Naval Air Rework Facility in 1969; and changed to its current name in 1987. Today, NADEP North Island is recognized throughout the world as an innovator in depot support.

With 3,900 personnel, NADEP North Island is one of the largest employers in San Diego, California. This full-service, world-class Depot handles maintenance engineering, logistics, and manufacturing services to the Fleet, and achieved $488 million in revenues for 1997. Although the focus is on aircraft, engines, and related component parts for aviation, the Depot is increasing its support to the Navy's amphibious, surface, and submarine forces. NADEP North Island provides engineering, calibration, manufacturing, overhaul, and repair services as well as administers engineering/airframe authority for the F/A-18 Hornet (including those flown by the Navy's Blue Angels), F-14 Tomcat, E-2C Hawkeye, C-2 Greyhound, and S-3 Viking aircraft programs. The Depot also dispatches field teams to deployed ships and military installations worldwide. These teams repair structures and components of aircraft; catapult and arresting gear on aircraft carriers; and aviation equipment and facilities on most classes of ships. Among the best practices documented were NADEP North Island's engineering development and structural analysis training program; consolidated control centers; plastic media blasting; and F/A-18 center barrel replacement.

Of all the aviation depots, North Island is the most diversified and most experienced in years of service. NADEP North Island prides itself on its ingenuity and teamwork. Constantly improving systems and tailored processes ensure that customers receive the highest quality product at the best value. A multi-talented, dedicated, and accomplished workforce enables NADEP North Island to exceed this goal. In addition to its primary mission, the Depot provides outstanding community outreach programs; participates in local educational partnerships; and advocates environmental and conservation efforts. As a result, NADEP North Island has received numerous awards including the 1997 California U.S. Senate Productivity Award for Manufacturing; 1997 Secretary of Defense Environmental Quality Award; 1996 Total Excellence in Management Award from the *San Diego Business Journal*; 1994 California Women in Government Award; and 1993 Rochester Institute of Technology/USA Today Quality Cup Award.

Like other government facilities, NADEP North Island faces changes, challenges, and opportunities. However, the Depot's pioneering spirit and commitment to excellence will enable it to remain at the forefront of technology and guide it into the next century. The BMP survey team considers the following practices to be among the best in industry and government.

Best Practices

The following best practices were documented at NADEP North Island:

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Test Program Set Delivery	**5**
Today, NADEP North Island uses Test Program Sets for its automated test equipment, which can test complex avionics for aircraft weapon systems support. The key to this process is to focus on test strategy, source coding, and integration.	
Aviation Maintenance Management Team Process	**5**
NADEP North Island developed an internal Aviation Maintenance Management Team process as a way of improving its performance during external audits. This systematic process addresses, captures, and resolves audit deficiencies. In addition, Subject Matter Experts and Activity Coordinators work together with Quality Assurance personnel to resolve shop and safety non-compliances.	

Information

The following information items were documented at NADEP North Island:

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Rotating and Electrical Center of Excellence 13

In 1996, the AH-1 Cobra starter motor and voltage regulator repair program were moved from NADEP Pensacola (Florida) to NADEP North Island. However, the original test equipment did not allow the Depot to meet the turnaround time requirements for NADEP North Island customers. The Depot resolved this issue by developing its own unique test equipment.

Shop Level Quality Plan 13

NADEP North Island developed a three-tier quality planning system as an alternative to ISO-9000. The third tier of the system is the Shop Level Quality Plan. This plan documents the quality policy; organization; roles and responsibilities; process and procedures; repair and rework; additional support; and self-audit requirements used within a shop.

Direct Digital Control Technology 14

Maintenance is a necessary expense which ensures that equipment performs within its specified parameters on demand and without interruption to schedule. Currently, NADEP North Island's Equipment Maintenance Department is in the planning stages of introducing Direct Digital Control technology into the workplace to monitor critical equipment and establish a predictive approach to equipment maintenance.

F/A-18 Engine and Auxiliary Power Unit Preservation 14

NADEP North Island expanded its Engine and Auxiliary Power Unit Preservation process to include the complex structural design and materials of F/A-18 engines. The Depot developed three levels of storage times/preservation procedures for F/A-18 engines which are installed or removed from aircraft.

Individual Qualification Reporting System 15

NADEP North Island developed the Individual Qualification Reporting System to help shop floor supervisors keep track of their employees' qualifications, certifications, and medical records. This computerized record-keeping system uses a relational database in a client/server environment.

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Labor-Management Partnership 16

Executive Order 12871 provided NADEP North Island with an opportunity to develop a constructive working partnership between its labor and management groups. This partnership enables the groups to work together in a non-adversarial environment.

Management Information System 16

NADEP North Island's Navy Primary Standards Laboratory provides a full range of primary-level metrology and calibration services to its worldwide customers with traceability to the National Institute of Standards and Technology. To meet today's greater mix of customers and technology requirements, the laboratory implemented an automated Management Information System.

Programmed Depot Maintenance Scheduling System 16

Following the Base Realignment and Closure Commission's decision in 1993, all S-3 Viking aircraft's Standard Depot Level Maintenance was moved from NADEP Alameda (California) to NADEP North Island. Since the Programmed Depot Maintenance Scheduling System was already being used at NADEP North Island for the E-2, C-2, and F-18 aircraft programs, the Depot adapted this system for the S-3 aircraft.

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Section 2

Best Practices

Test

Test Program Set Delivery

In the past, Naval Aviation Depot (NADEP) North Island relied on a repetitive, labor-intensive method for avionics testing, which often lowered throughput and slowed repair efforts. Approximately 90% of a test set's development time and labor costs came from engineering, logistics, project management, and configuration management. Most developments were characterized by no baseline designs as well as extensive and multiple design reviews. Product integration consumed almost 70% of each task, and extensive rework lengthened the overall process. The average timeline for development was 60 weeks.

Today, NADEP North Island uses Test Program Sets for its automated test equipment, which can test complex avionics for aircraft weapon systems support. The key to this process is to focus on test strategy, source coding, and integration. In addition, cost drivers for development are identified. To improve the design and fabrication phases, 50% of the assembly is pre-wired with standard modules. This approach lowers the manufacturing task substantially, and allows hardware to be baselined with only front-panel changes required for specific avionic parts. The average timeline for development is now 16 weeks.

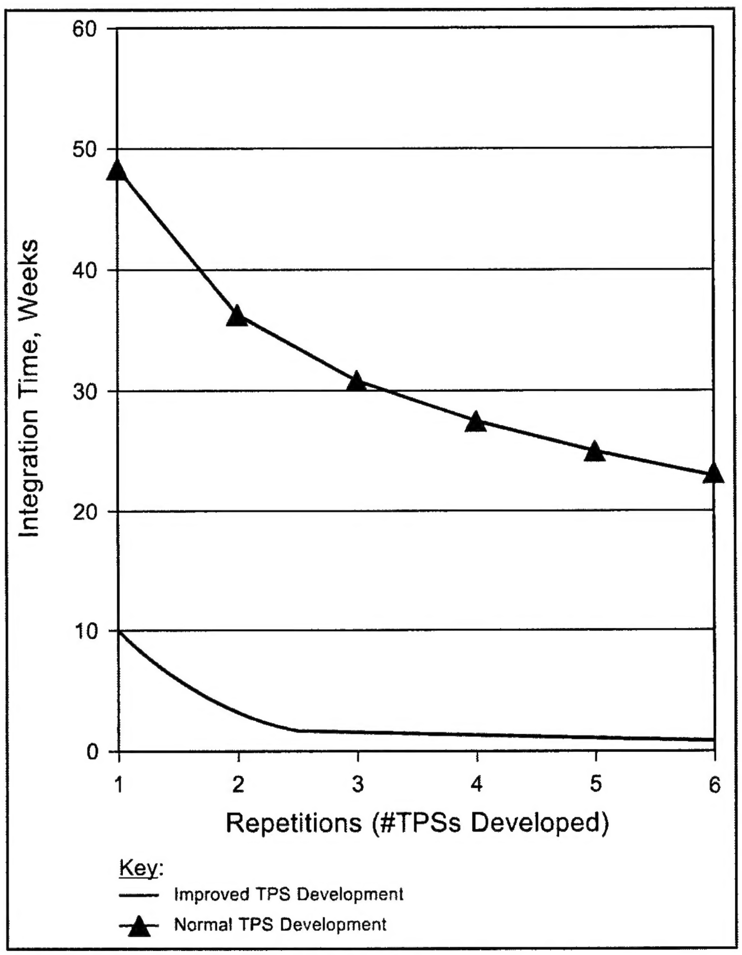


Figure 2-1. Cycle Time Reduction

By using the Test Program Sets, NADEP North Island improved the overall process; reduced time and labor; and enabled engineers to achieve maximum productivity (Figure 2-1). Good systems engineering practices improved employee morale, and contributed to reduced development costs, cycle times, and integration periods. NADEP North Island also realized a reduction in production overhead costs that were directly related to the Test Program Sets' equipment. The Test Program Sets enabled NADEP North Island to focus its engineering efforts on near-term results.

Production

Aviation Maintenance Management Team Process

Like other depots, NADEP North Island is subjected to external audits from Naval Air Systems Command's (NAVAIR's) Aviation Maintenance Management Team (AMMT). As a way of improving its performance during these audits, NADEP North Island set up an internal AMMT process. This systematic process addresses, captures, and resolves audit deficiencies. In addition, Subject Matter Experts (SMEs) and Activity Coordinators (ACs) work to-

gether with Quality Assurance (QA) personnel to resolve shop and safety non-compliances. These groups have an interdependent relationship in performing process improvement activities. As a result, NADEP North Island now performs internal audits, three times a year, on 30 of its processes including personnel safety; oil and gas hazards; aircraft tie downs; and engine preservation.

SMEs consist of personnel from support activities such as Production Control, Industrial Engineering, Plant Services, and the Naval Cal Laboratory. They perform formal plant audits, identify deficiency root causes, and develop compliance recommendations. ACs consist of 30 employees from each process area. They analyze audit deficiencies, eliminate root causes, implement corrective action plans, and monitor their outcome and ensure process improvements and compliances. The AC Corrective Action Plan development is a formalized, two-step process. The first step analyzes the status of non-compliances, while the second stabilizes them through root cause analysis, feedback, team participation, and supporting metrics. However, a Corrective Action Plan must also determine how program goals are tied to corrective actions; the balance between short- and long-term corrective actions; the relevance and ease of tracking milestones; pertinent metrics; and appropriate critical performance indicators.

SMEs and ACs are responsible for industrial process improvements, and ACs and production managers are responsible for related workflow process improvements. By using ACs to coordinate industrial and workflow process corrective actions, the AMMT process ensures that integrated improvements are developed and applied. These areas are also linked by a common, closed-loop system strategy that identifies, stabilizes (prevent recurrence), and improves the process under review. The outcome is the development of benchmarks, process improvements, and strategic initiatives. A booklet with each internal audit's results is published twice a year in conjunction with each internal audit. This matches up well with the self-auditing philosophy of ISO-9000 quality system requirements.

The AMMT process was phased into NADEP North Island's manufacturing processes and safety programs as a prototype in 1996. The process was formalized in 1997 and completely institutionalized in 1998. Since 1996, NADEP North Island steadily reduced its critical deficiencies from 15 to two, and its unsatisfactory deficiencies from nine to five. The goal is to achieve total compliance (e.g., zero critical and noncompliant findings).

Composite Repair

NADEP North Island developed an organic capability for performing composite repairs on aircraft skin and flight control surfaces. In the past, damaged composite parts (e.g., wings, stabilizers, flight control surfaces) were scrapped and replaced with new parts from the manufacturer. By creating a Composite Repair capability, NADEP North Island can restore and reuse these expensive, long lead-time items.

Much of the work involves small surface areas, which are repaired with localized vacuum bags and pre-cured composite patches. These flexible film bags provide a seal around components and create a negative pressure, so resinous materials can properly cure during the repair process. NADEP North Island employs two types of bags. Whole vacuum bags are used to completely cover the damaged component, while partial vacuum bags cover only the portion of the surface being repaired. Breather fabrics are used to expedite the removal of air and other volatile materials from within the bag. Bleeder fabrics are used to remove excess resin during the curing cycle. In addition, release films and fabrics help prevent resin from adhering to a tool or to areas on the component where adhesion would be undesirable. A typical vacuum bag installation is shown in Figure 2-2.

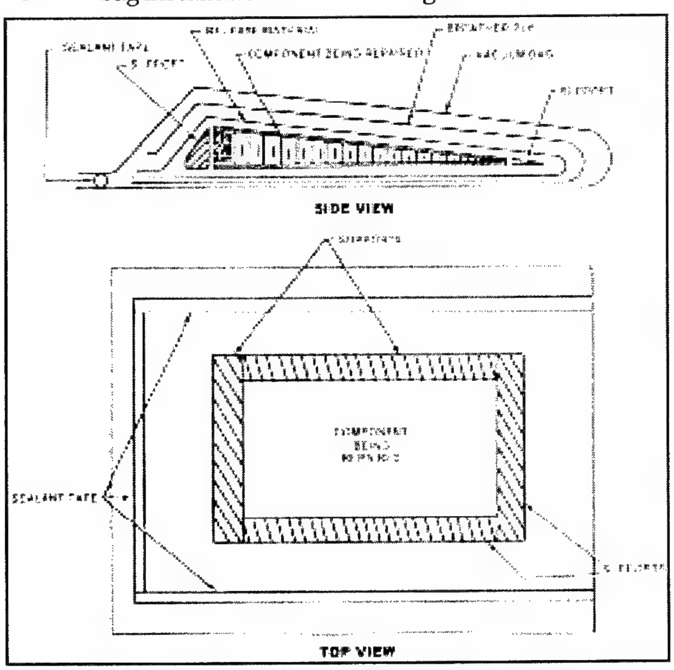


Figure 2-2. Typical Vacuum Bag Installation

For most applications on small area patches, curing is done via a heating pad. In cases of larger repairs or in the manufacture of replacement components, NADEP North Island uses either its three-foot, seven-foot, or 12-foot autoclave. The Depot also refined its processes, and provided pre-cut/pre-cured repair kits for use in the Fleet. This approach provides further savings by eliminating the need for components to be sent to the Depot, because the repairs can be carried out in the Fleet.

F/A-18 Center Barrel Replacement

NADEP North Island is responsible for the F/A-18 In-Service Repair (ISR) program, which covers the repair of aircraft damage that is incidental to Fleet operations and considered beyond the Fleet's capability to restore the aircraft to flight status. Typical examples include heat damage, extensive corrosion, and/or structural repairs to the airframe. In addition to handling the ISR program, NADEP North Island developed a special rework program that focuses on major repair efforts, resulting from crash/mishap damages requiring airframe remanufacture.

Prior to initiating the F/A-18 Center Barrel Replacement program, the Depot did not have the capability to salvage aircraft which had experienced center-fuselage overstress conditions typically caused by hard carrier landings, runway departures, landing gear failures, or in-flight fires. The only alternative was to replace the entire aircraft. In 1991, a team of engineers, technicians, and artisans developed a method along with a series of techniques that allow the damaged center fuselage section of an F/A-18 to be removed and replaced with a new section.

The F/A-18 Center Barrel Replacement process involves separating the fuselage at points other than those used during new construction. This technique minimizes labor and material consumption by replacing only the overstressed structure of the airframe. By using the fixture and tooling designed at NADEP North Island for this process, the alignment of the replacement section to the rest of the fuselage structure is maintained to the original design specifications and tolerances. This claim was demonstrated when the process, prototyped in 1991, was used to repair an aircraft with less than 500 flight hours which had experienced a hard landing. This prototype effort resulted in returning the aircraft to operational use at a cost of $5.5 million. These costs included the non-recurring costs of $3.15 million for the development and manufacture of the fixture, material, tooling, techniques, and processes. Since incorporating the process for repairs of this nature, NADEP North Island has made modifications, so that the process can be used on other types of repairs as well as for replacements to the airframe structure.

To date, the total cost avoidance savings for the F/A-18 Hornet program is $327.8 million. The F/A-18 Center Barrel Replacement process provides NADEP North Island with a unique repair capability, and ensures the maximum life usefulness of the F/A-18 well into the 21st century.

Flight Critical Manufacturing

Flight critical parts are defined as any single part of the aircraft which, should it fail during operating conditions, can result in the loss of the aircraft or one of its major components. In accordance with NAVAIR requirements, each depot must develop and follow a unique process, governing the manufacture of flight critical parts. These requirements ensure that all quality and manufacturing attributes of flight critical parts are fully auditable through historical documentation, from initial order to finished product and installation.

NADEP North Island developed the Flight Critical Manufacturing process to comply with NAVAIR requirements. As shown in Figure 2-3, the flow diagram lists the steps which flight critical parts must follow during manufacturing. NADEP North Island has determined that 85% of the parts governed by the Flight Critical Manufacturing process have previously been made and use a manufacturing process already approved. Since these are repeat jobs, there is no need to have the process signed-off by a Senior Review Board. In the past, NADEP North Island required a sign-off on all parts, regardless of whether they were previously manufactured. Since the Senior Review Board only met once a week, delays often occurred and would impact the customer's needs. To improve this situation, NADEP North Island now requires only first-time parts to follow this practice. Repeat parts can be signed-off by the appropriate senior manager, thereby improving the response time to the customer and ensuring that the part's traceability and documentation are maintained. The use of local certified vendors and excess certified material (retained from previous jobs) has also helped to reduce the turnaround time for manufacturing these parts.

The Flight Critical Manufacturing process eliminates non-value steps and focuses on those which contribute to the quality and auditability of flight

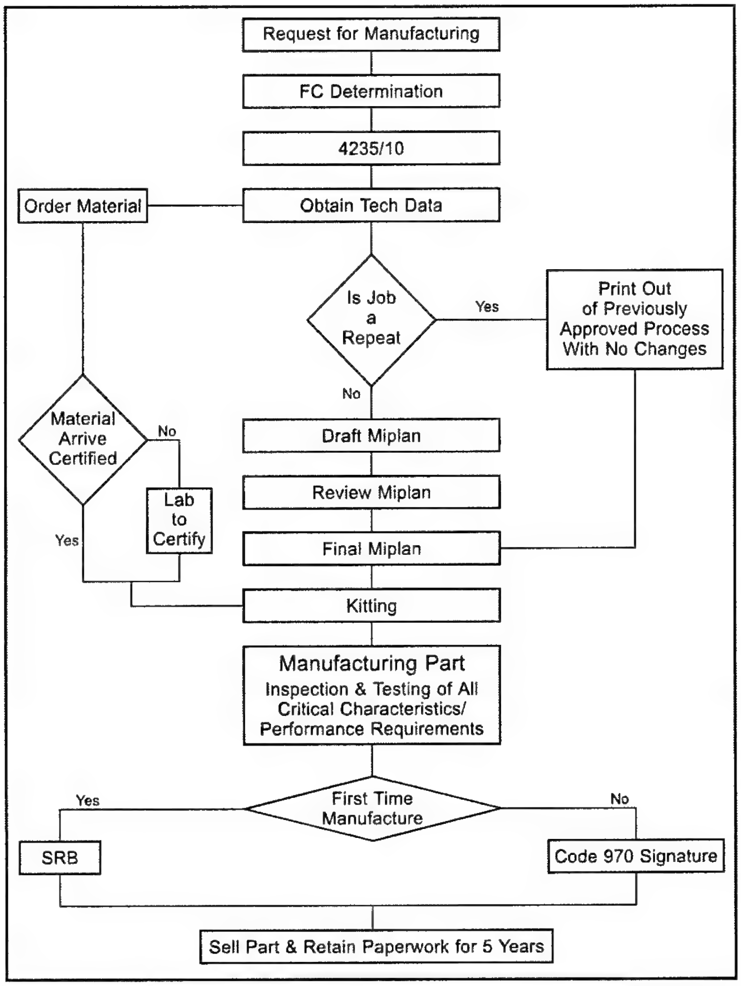


Figure 2-3. Flight Critical Manufacturing Flow Diagram

critical parts. This streamlined process enables NADEP North Island to reduce costs, improve turnaround time, meet customers' needs, and comply with NAVAIR requirements.

Hazardous Material Management System

In the past, shop artisans at NADEP North Island were responsible for hazardous material management (e.g., inventory, shelf life, accountability). Each shop maintained at least three hazardous material lockers, and each building housed approximately 15 shops. Many times, these shops placed large orders for short-term products. However, no system existed for excess hazardous materials to be shared among the shops or buildings. As a result, an oversupply of hazardous material was created. Once its shelf life expired, the material would be disposed as hazardous waste. Delivery orders were typically slow, which delayed production, and Material Safety Data Sheets (MSDSs) were often outdated.

In March 1995, NADEP North Island implemented the Hazardous Material Management System (HMMS) to track its hazardous material usage and consumption. This cradle-to-grave tracking system establishes centrally controlled and managed Hazardous Material Distribution Support Centers (HMDSCs) per the philosophy of the Navy-wide Consolidated Hazardous Material Reutilization Management program. NADEP North Island set up HMDSCs in eight of the ten major industrial buildings where hazardous materials are used, and established satellite areas in smaller buildings. By linking HMDSCs via computer, the Depot improved inventory control and shelf life management.

HMMS tracks and manages all hazardous materials at NADEP North Island by recording product information, time and place of issue, and shop artisan information. Each hazardous material container has a yellow barcode label which is serialized and provides traceability to the recipient. HMMS allows shop artisans on the floor to obtain manufacturer safety information by accessing on-line MSDSs. The system also gives users immediate access to Health Hazard Data for medical personnel.

Shop artisans are linked to a Hazardous Materials Authorized Users List via shop zones, which ensures that artisans can only obtain those materials which are approved for their zone. The HMDSC attendant enters the artisan's pay number and scans the container's serial number which records the hazardous material's classification, weight at time of issue, and targeted use (e.g., component, aircraft). The process verifies whether the material is authorized for the artisan's assigned zone. When the material is returned, the HMDSC attendant re-scans the serial number and keys in the material's weight. The remaining material is stored or disposed in accordance with Environmental Protection Agency regulations.

Since implementing HMMS, NADEP North Island improved inventory control, traceability, and delivery time for its hazardous material. The Depot estimates a 30% reduction in both hazardous material purchases and hazardous waste generation at the HMDSCs already established.

Plastic Media Blasting

Prior to 1994, NADEP North Island used wet epoxy strippers containing phenols, chromates, and methylene chlorides to remove paint from exterior airframe surfaces. These chemicals tend to damage composite structural materials, contribute to toxicity, and create environmentally hazardous waste. To eliminate these problems, NADEP North Island switched to Plastic Media Blasting (PMB) for its paint stripping operations, hard and brittle adhesive sealant removal, and for light corrosion removal from aluminum, titanium, magnesium, and steel.

PMB works by using an abrasive media (granulated acrylic thermoplastic) and an abrasive blasting technique (compressed air blasting). Together, these components operate as an impact cleaning process in which the plastic media is propelled by compressed air against a surface. A media recovery system is used in conjunction with the blasting equipment. The system separates the reusable particles from dust, and passes them through a magnetic field to trap tramp iron particles. A subcontractor then collects the spent media for use in the manufacturing of picnic tables, counter tops, trophies, and furniture. NADEP North Island uses a PMB lease program to reduce costs.

PMB is an effective, environmentally safe alternative to chemical stripping. Although NADEP North Island uses PMB for most of its paint stripping operations, a few situations still remain where customers require the Depot to use chemical stripping. Since implementing PMB, the Depot improved productivity, reduced job-related injuries, and realized significant savings. Specifically, NADEP North Island decreased process time from eight hours to two; cleanup time from one hour to 0.5 hour; and material costs from $150 to $50. PMB also eliminates the need for disposal costs associated with chemical stripping.

Unicoat Paint Process

Prior to 1996, NADEP North Island used a traditional, multi-coat method (a primer coat and several layers of topcoats) to apply paint to aircraft surfaces. In 1996, the Depot implemented the Unicoat Paint process, which uses a single coat of paint to accomplish the same task. This process improved productivity and reduced hazardous waste by 50%.

The Unicoat Paint process is a revolutionary method which enables technicians to paint an aircraft in about two hours, compared to four with the previous method. In addition, the painted surface takes on a smooth and laser-like finish after drying. This visual appearance is one of the key attractions of the process. Many of NADEP North Island's customers are now requesting the Unicoat Paint process for their aircraft.

Although the unicoat paint costs approximately $113 per kit compared to $43 per kit for the traditional topcoat paint, the overall savings from the newer process are much greater. The Unicoat Paint process provides the following benefits:

- Requires less man-hours and processing time
- Requires less paint and related materials
- Reduces aircraft turnaround time
- Reduces hazardous waste
- Prevents excessive discharge of chromate into the atmosphere
- Prevents excessive employee exposure to chromate

Since implementing the Unicoat Paint process, NADEP North Island significantly improved its paint operations. This process offers an efficient and effective way to apply paint to aircraft surfaces.

Facilities

Three-Stage Air Filtration System

An integral part of paint operations is the removal and proper disposal of overspray. This process becomes more complicated for very large activities such as painting aircraft. In addition, aircraft paint facilities are required to meet stringent federal, state, and city regulations pertaining to emission standards for hazardous pollutants. Non-compliance results in penalties or the shut-down of operations; delays delivery to customers; and creates greater expense for aircraft maintenance and repair operations. In 1997, NADEP North Island began upgrading its eight large bay paint cells to accommodate a three-stage air filtration system. These renovations were completed in 1998.

NADEP North Island's filtration system consists of three layers of filter stages which are placed one behind the other. The first stage (non-dyed polyester media consisting of 15 and 40 denier fibers) filters out coarse, tacky paint particles while the second stage (two separate layers of non-dyed polyester media consisting of six and 15 denier fibers) stops finer and dryer particles. The third stage consists of a fine, tightly woven material (polypropylene media formed into a filter of at least six pockets), and is designed to stop the smallest paint particles. Together, these filters enable the system to exceed the required 95% efficiency requirement. In addition, NADEP North Island added two layers of pre-filters to the second stage, which reduces the changeout frequency of the

air filters in the second stage as well as the more expensive third stage. Other upgrades include variable speed drives for controlling airflow, electronic sensor monitoring of filter contamination levels, and airflow monitoring. The Depot maintains daily log books for recording all data.

The three-stage air filtration system is adaptable to any type of paint medium including chromates. Since implementing the system, NADEP North Island increased its efficiency to 99% and now exceeds all federal, state, and city regulations for paint operations. The filtration system also maintains a linear air flow, produces cleaner emissions, and provides a safer environment to the public.

Management

Consolidated Control Centers

Previously, NADEP North Island operated in a traditional top-down, functional mode with relatively little communication among departments and work centers. In 1991, the Depot implemented a highly effective, team-based approach which used multilevel personnel and facilitated the free flow of information from work centers to senior management. This approach became the core process for communications, problem solving, and continuous improvement at the Depot. The focal points for the process are Consolidated Control Centers (CCCs) which are set up as teams in each major commodity group or product center (e.g., avionics, instruments, hydraulics, rotating electric). NADEP North Island currently uses ten CCC teams which focus on product-related issues, and one Material Control Center (MCC) team which focuses on parts and materials issues.

The teams set up personal and group goals; encourage members to take ownership of issues; and receive support from senior management. Active participation, open communications, and a cooperative environment enable the teams to produce rapid resolutions for conflicts and increase productivity. Problem solving consists of stating what appears to be the problem; gathering facts, feelings, and opinions; restating the problem; identifying alternative solutions; evaluating the alternatives; implementing the decision; evaluating the results; and performing follow-up for long-term solution. The teams are empowered by NADEP North Island to carry out this process. All CCC and MCC members are trained in team building and group decision-making skills.

Each team consists of one production representative per shop; two planners/estimators; one production control representative per shop; one equipment specialist per shop; one industrial engineering technician per shop; and two QA specialists. Production representatives identify impediments to the shop's ability to produce on-schedule, and provide trade knowledge, capability, capacity, and operations of the shop. Planner/estimators develop induction and production plans for all programs, and assist with the identification and resolution of production impediments. Production control representatives coordinate and provide support to the execution of predetermined workload schedules; advise appropriate levels of management on the status of specific work; expedite the progress of work in process and material requirements; and set and review priorities. Equipment specialists coordinate procurement of material, parts, and supplies; investigate high usage or rejection of material; take action on parts shortages; and maintain communications with customers, contractors, and vendors. Industrial engineering technicians conduct work sampling studies, and develop and maintain operation, product, and work standards. QA specialists verify product and process quality.

Information developed by each team is consolidated into standardized charts and displayed in the Command Information Center located on the Depot's Quarterdeck. These charts clearly and visually show all of the key information needed by management to optimize and control the work at NADEP North Island. A weekly meeting attended by managers and supervisors is held at the Command Information Center to review this data. The visual presentation allows participants to see and review the status of every program, product, and process. This format also provides an effective way to quickly communicate information across the Depot, and ensures that important data will effectively travel between the factory floor and upper management.

The CCC approach is successful at NADEP North Island because of its interface through the Command Information Center. Since implementing this approach, the Depot dramatically decreased turnaround times for its major aircraft programs; achieved significant cost and time savings; and increased the total number of units produced.

Engineering Development and Structural Analysis Training Program

In the past, NADEP North Island's training approach for newly hired employees was disorganized and provided minimal certification. Some employees actively searched additional avenues of learning, but

most were content with their initial training. With this approach, less than 20% of the engineering workforce met the Navy's performance training requirements and/or could responsibly execute engineering tasks in a team atmosphere. NADEP North Island resolved this situation by implementing an Engineering Development and Structural Analysis training program.

Administered by the Structures Competency Management, this program is a comprehensive process that affects all newly hired or reassigned engineers (GS-5 to GS-11) within the Structures Competency Management who are not covered under existing Navy personnel training programs. This program provides training for engineering development and certification for structural analysis codes within the Competency and the Field Activity. In addition to the training, the Depot uses a highly successful mentoring program. As a result, NADEP North Island's skill base can now match industry's state-of-the-art capabilities. Computer aided engineering systems are employed to mathematically model aircraft part geometry and perform structural analysis using finite element modeling. The Depot also uses numerous commercial PC analysis tools (e.g., MathCad, Pro-Mechanica, NISA II), and has expanded its in-house developed tools to include notch-strain analysis, spring constants, joint modeling, and lug analysis.

The Engineering Development and Structural Analysis training program enabled NADEP North Island to stabilize and significantly improve its engineering workforce despite being in a downsizing environment. The workforce now exceeds the Navy's performance training requirements by 97%. In addition, the staff is fully integrated into the Depot's F/A-18 E/F structures program which makes them eligible to prepare, review, and release technical and local engineering directives that will affect the aircraft for years to come.

Engineering Development Assistance Program

Aircraft maintenance and support operations require the use of highly skilled engineers and scientists who can perform state-of-the-art structural analysis and modeling. However, competition for this type of employee is high in southern California. NADEP North Island began addressing this issue in 1983 by creating an Upward Mobility program. Over the years, the program was redesigned as the Engineering Development Assistance Program (EDAP) to make it more attractive to the workforce and to help resolve the Depot's employee shortage.

EDAP is one of the most popular programs among blue collar workers at NADEP North Island. Candidates are selected based on standard merit promotion principles. Human Resources personnel use a crediting plan (e.g., work performance, education, accomplishments) to rank the candidates. Engineering Managers choose the finalists based on their aptitude in engineering, mathematics, and science, and their ability to compete in an engineering/scientific curriculum. The Depot's needs determine how many openings are available for EDAP (e.g., eight applicants were selected during the last EDAP vacancy advertisement).

This work study program is funded under Administrative Indirect, Training, and Development. The program allows participants to enroll in an engineering/scientific curriculum at an accredited college/university. All matriculation and required text fees are reimbursed by the Depot. While attending school, the employee is reassigned from the factory floor to one of several engineering technician job series. A designated amount of time each week is allocated to the employee for studies. The maximum is three days for full-time students and ten hours for part-time students. Participants must maintain acceptable levels of performance in school and in their assigned position. Managers work with participants to set up appropriate work schedules; establish individual development plans; designate mentors/coaches; and evaluate the employees' performance and progress.

NADEP North Island gained significant benefits by using EDAP. Employee loyalty has increased, and the Depot now meets its demand for qualified engineers and scientists. To date, 80 employees have participated in EDAP. Approximately 96% of those who start EDAP will complete the program. The retention rate is also high. Over the past five years, only one EDAP participant left the Depot.

Section 3
Information

Test

Rotating and Electrical Center of Excellence

In 1996, the AH-1 Cobra starter motor and voltage regulator repair programs were moved from NADEP Pensacola (Florida) to NADEP North Island. However, the original test equipment did not allow the Depot to meet the turnaround time requirements for NADEP North Island customers. The Depot resolved this issue by developing its own unique test equipment.

The original starter motor dynamometer test stands were designed to test torpedoes and had been modified to test the AH-1 Cobra helicopter's starter motor. As a result, the stands were unreliable; required aircraft batteries and a motor generator for power; and produced excessive heat, noise, and dust due to the pneumatic friction braking system. The redesigned dynamometer test stands feature a solid state power supply from the plating shop for powering the system; magnetic effects for braking which prevent parts from touching; and a personal computer to replace the strip chart recorder for data display and storage. These improvements greatly reduced the repair turnaround time for AH-1 Cobra starter motors. The total cost to develop the new starter motor test stand was less than the cost of a single starter motor. NADEP North Island is currently using reverse engineering to develop a printed circuit board module test set for the new starter. Process procedures are also being developed to rewind starter and generator motors. The Depot anticipates a one-week turnaround time for performing starter motor rewind.

The AH-1 Cobra voltage regulator test set consists of two testers: the open-loop work aid and the closed-loop tester. NADEP North Island determined that the open-loop work aid only tests 20% of the voltage regulator's circuitry. The closed-loop tester tests additional circuitry; however, it does not provide sufficient information regarding fault isolation. To resolve this issue, the Depot uses shunt simulation and bus fault simulation which enable 90% of the circuitry to be tested and fault-isolated. This approach greatly reduced the repair turnaround time for AH-1 Cobra voltage regulators. Revised NAVAIR repair procedures, work packages, and local engineering specifications for the new voltage regulator test equipment will be made available to the shop floor by the end of October 1998.

NADEP North Island significantly improved the AH-1 Cobra starter motor and voltage regulator repair programs by redesigning the test equipment. As a result, the number of AH-1 Cobra helicopters out of service, due to starter motor and/or voltage regulator failures, dropped from 15 to zero. The Depot's redesigned starter motor test stand is more reliable and its voltage regulator test set can fault-isolate to a lower level than the original test equipment.

Production

Shop Level Quality Plan

NADEP North Island developed a three-tier quality planning system. The first tier is the Depot Level Quality Program Manual which establishes policy guidelines and procedures for a standardized quality program. This manual was developed by the QA department as a formal document. The second tier is the Manufacturing Program Quality Plan which establishes general quality policy, procedures, and practices within a program. This plan is currently in the prototype stage. The third tier is the Shop Level Quality Plan. This plan documents the quality policy; organization; roles and responsibilities; process and procedures; repair and rework; additional support; and self-audit requirements used within a shop. Although the three-tier quality planning system is based on ISO-9000 requirements, the decision on whether to seek ISO-9000 certification is still being determined by NAVAIR and NADEP North Island's Executive Steering Committee.

NADEP North Island's Code 970 Manufacturing Program began developing Shop Level Quality Plans for its manufacturing shops to comply with the program's strict quality, cost, and schedule requirements. These requirements are driven by NAVAIR depot quality standards to help local productivity keep up with industry's production efficiency. A Shop Level Quality Plan is written by a team of shop personnel (e.g., artisans, supervisors, QA personnel, engineers) who meet once a week for an hour, until the task is completed. The average development time for a plan is about five months. In March 1998, the Plating Shop implemented the first Shop Level Quality Plan.

NADEP North Island expects to complete 50% of the Shop Level Quality Plans for the remaining 19 shops of Code 970 by July 1999. Essential to these plans is NAVAIR's policy that all employees be responsible for the quality of their work.

The Shop Level Quality Plan is a good alternative to ISO-9000. Should NAVAIR and/or the Executive Steering Committee decide to implement an ISO-9000 quality program, the Depot's three-tier quality planning system will require minimal adjustment to comply with ISO-9000 certification requirements.

Facilities

Direct Digital Control Technology

More than 285,000 pieces of equipment (e.g., multi-axis milling machines, lathes, drills, grinders, apparatus for plating, painting, and plastic media blasting) support the mission of NADEP North Island. This equipment, valued at $540 million, supports a full spectrum of aircraft overhaul/repair as well as emergency depot repair. Maintenance is a necessary expense which ensures that equipment performs within its specified parameters on demand and without interruption to schedule. The Depot's Equipment Maintenance Department is responsible for executing maintenance in the most cost effective and efficient manner possible. Currently, this Department is in the planning stages of introducing Direct Digital Control (DDC) technology into the workplace to monitor critical equipment and establish a predictive approach to equipment maintenance.

In the past, NADEP North Island executed equipment maintenance on a periodic scheduling basis. All equipment followed this schedule regardless of its need for maintenance. This routine application of labor/materials creates a high-cost driver for equipment maintenance. The solution is to perform maintenance based on equipment wear and degradation. DDC technology is an integral part of this solution. This technology operates as a network of microprocessors used for precise monitoring of equipment temperature, dimension, humidity, smoke, dust, amperage usage, vibration, time duration, pressure, and pH factor. DDC technology allows facility managers/maintenance personnel to conduct precise measurements and monitor key parameters via a graphic interface.

NADEP North Island already uses DDC technology for its facility support systems such as HVAC, fire alarms, intrusion alarms, steam traps, grinders, lighting, filters, and motors. The Equipment Maintenance Department plans to reduce maintenance cost by extending DDC technology to the Depot's equipment. Building 472, Section E is targeted for this technology. This area contains a high concentration of milling, boring, grinding, and measuring machines.

By using DDC technology, NADEP North Island will be able to capture a true indication of equipment usage; keep a history of maintenance data and equipment utilization; and predict the need for maintenance, replacement, or disposal. This technology will also reduce equipment downtime and increase the overall productivity of the Depot. Customers will see these benefits as reduced cost, improved quality, and on-time delivery of their products.

Logistics

F/A-18 Engine and Auxiliary Power Unit Preservation

NADEP North Island expanded its Engine and Auxiliary Power Unit (APU) Preservation process to include the complex structural design and materials of F/A-18 engines. The Depot developed three levels of storage times/preservation procedures for F/A-18 engines which are installed or removed from aircraft. Effective preservation of installed engines, removed engines, and APUs is done by sealing all openings with barrier paper; applying corrosion prevention control (CPC) coatings; and performing periodic engine rotations and inspections.

Level I (storage up to 90 days) preservation requirements for installed engines:

- Maintain fuel system at 95% full with a seven-day inspection;
- Seal all seams and openings; and
- Perform a 28-day inspection to hot run, operate the system, and check external coatings.

Level II (storage up to one year) preservation requirements for installed engines:

- Defuel and run 1010 oil through engine;
- Spray compressor blades with 1010 oil;
- Seal openings with barrier paper and install desiccant with humidity indicator;
- Perform a daily inspection of the previously listed practices;
- Perform a seven-day inspection of humidity indicator;
- Perform a 28-day inspection of CPC coating;
- Perform a 56-day rotation of the engine; and
- Reapply 1010 oil on compressor blades.

Level III (storage greater than one year) preservation requirements for installed engines:

- Conduct a Level II internal protection; and
- Store entire aircraft in a dehumidified storage container.

NADEP North Island stores aircraft in a dehumidified bag consisting of plastic tarps with zip lock seams. This unique storage method was started in 1980, and saves on building space and overhead. The dehumidification of the aircraft bags is maintained through individual hose hook-ups to an external dehumidifier. The Depot also uses portable dehumidifiers which allow aircraft to be shipped while in a preservation bag.

Level I (storage up to seven days) preservation requirements for removed engines:

- Mount engine on an approved test stand;
- Seal all seams and openings;
- Cap and plug all fittings and lines; and
- Apply CPC coating to bare metal.

Level II (storage up to eight months) preservation requirements for removed engines:

- Conduct a Level I internal protection;
- Install desiccant with humidity indicator;
- Perform a seven-day inspection of integrity and humidity indicator;
- Perform a 28-day inspection of CPC coating;
- Perform a 56-day rotation of the engine by hand;
- Reapply 1010 oil on the compressor blades if possible;
- Complete maintenance checklist and log provided by the QA department; and
- Attach a warning label to the stored engine which lists the number of desiccant bags that are to be removed before placing the engine back in service.

Level III (storage greater than eight months) preservation requirements for removed engines:

- Conduct a Level II internal protection;
- Cap and plug of all fittings;
- Store engine in a dehumidified storage container, room, or bag;
- Perform a 28-day inspection of humidity indicator;
- Complete maintenance checklist and log provided by the QA department; and
- Attach a warning label to the stored engine which lists the number of desiccant bags that are to be removed before placing the engine back in service.

NADEP North Island's Engine and APU Preservation process significantly contributes to the operational readiness of F/A-18 engines. This process effectively prevents the engines from degrading during inactive periods.

Management

Individual Qualification Reporting System

NADEP North Island developed the Individual Qualification Reporting System (IQRS) to help shop floor supervisors keep track of their employees' qualifications, certifications, and medical records. This computerized record-keeping system uses a relational database in a client/server environment. All data is linked to the employee database which provides individual information such as pay number, current shop, and permanent shop.

The IQRS consists of six modules:

- Individual Qualification Record module — Used to enter individual tasks, qualifications, and initial/completion dates pertaining to training and re-qualification data. All tasks are certified by the trainer, supervisor, and employee via personal identification passwords.
- Skills module — Keeps track of licensing, certification programs, special process, stamp, refresher training, revocation information, and history of employees. This module also maintains active and inactive databases.
- Medical Surveillance module — Enables the Safety Office to enter individual medical appointments for employees. All phases of appointments (e.g., scheduled, completed, no-shows) are tracked by the system and displayed to the supervisor.
- Respirator Training module — Maintains a list of certified employees and shows which respirators they are qualified to use. The module also provides information on the equipment such as manufacturer, model, and type.
- Planning and Inventory Control module — Used by supervisors, planners, industrial engineers, and production control personnel to plan and control the workload.
- Calibration module — Displays a list of equipment and tooling that needs to be calibrated. The module also indicates the due date and which cognizant shop has custody of the equipment.

The IQRS provides NADEP North Island with a quick, easy, and reliable way to keep track of its employees' certifications and qualifications. By computerizing the records, the Depot maintains up-to-date records and eliminates historical gaps. Supervisors can also run reports which verify or flag information that could impact the scheduling of assigned work.

Labor-Management Partnership

Executive Order 12871 provided NADEP North Island with an opportunity to develop a constructive working partnership between its labor and management groups. This partnership enables the groups to work together in a non-adversarial environment.

First, NADEP North Island set up a joint labor-management team to develop the partnership's structure and process that would be beneficial to all. Then, the labor organizations were consolidated and moved to a common location to promote ease of access. Next, the Office of Civilian Personnel Management provided team members with training through its Planning for Partnership course. This course ensured that the members understood the intent and goals of Executive Order 12871 and the partnership. Today, labor representatives are full team members, participate in the Depot's management meetings, and meet with the Executive Steering Committee whenever issues arise.

Through the Labor-Management Partnership, union officials and management representatives can identify issues and develop solutions by working toward common goals. This partnership has also decreased the number of grievances. Union members filed 211 first-step, 180 second-step, and 85 third-step grievances in 1996 compared to 170 first-step, 140 second-step, and 65 third-step grievances in 1997. One labor organization reported a 95% decrease in filed grievances by its members since the implementation of Executive Order 12871. NADEP North Island expects this trend to continue in the years ahead.

Management Information System

NADEP North Island's Navy Primary Standards Laboratory (NPSL) provides a full range of primary-level metrology and calibration services to its worldwide customers with traceability to the National Institute of Standards and Technology (NIST). This calibration facility is the only one in the Nation sanctioned by NIST in the field of magnetics, and the only Type I standards laboratory in the Navy. To meet today's greater mix of customers and technology requirements, NPSL implemented an automated Management Information system.

In the past, NPSL manually tracked/controlled its workload, finances, and work in progress (WIP). The laboratory handled approximately 5,000 standards per year for five major customers. This workload was processed by 100 employees at a cost of $6 to $10 million. NPSL also used a Visual Identification Display System (VIDS) board to monitor its shipping and receiving. Shipping documents were manually typed which often led to an out-of-date listing of the laboratory's measurement capabilities. Although finance, WIP, and backlog information were automated, no interface existed among them.

Today, NPSL uses automated tracking/control for its workload and real-time access for financial, WIP, and technical information. This Management Information system also allows the laboratory to interface with customers. Budget analysts provide real-time financial and WIP information to program sponsors and customers. Likewise, equipment specialists and laboratory artisans give WIP and technical information directly to their customers. Over the past 15 years, the volume of NPSL's workload remains unchanged. However, the complexity of the standards has increased, and customers now place more importance on traceability, lower costs, and turnaround times.

Since implementing the Management Information system, NPSL became more efficient. The laboratory now handles 5,000 standards per year for 150 customers, which can be processed by 40 employees at a cost of $3 to $4 million. In meeting this new business environment, NPSL installed a local area network and developed its own software to automate and integrate finance, WIP, backlog, shipping, and receiving information. As a result, NPSL eliminated the VIDS board and the manual generation of reports. A web site was also created to provide easy accessibility to a current, complete listing of the laboratory's measurement capabilities.

Programmed Depot Maintenance Scheduling System

Following the Base Realignment and Closure Commission's decision in 1993, all S-3 Viking aircraft's Standard Depot Level Maintenance (SDLM) was moved from NADEP Alameda (California) to NADEP North Island. This transition was completed in 1996. Approximately two-thirds of personnel assigned to S-3 SDLM came from Alameda. As a result, NADEP North

Island faced various challenges in integrating the new employees into its workforce. Incompatibilities existed between the two Depots' work processes, approaches, and shop floor management. Since the Programmed Depot Maintenance Scheduling System (PDMSS) was already being used at NADEP North Island for the E-2, C-2, and F-18 aircraft programs, the Depot selected this system for the S-3 aircraft.

PDMSS is a relational database system which was adapted to the S-3 aircraft program. The software support contractor, who developed and maintains PDMSS, worked with NADEP North Island to customize and upgrade this system for the S-3 aircraft program. The S-3 SDLM is a major work-package, involving the removal of more than 3,500 components and 15,000 labor hours. The S-3 is a relatively old aircraft with poor spare parts support. Many spares are back robbed from other Fleet aircraft to complete S-3 SDLM. PDMSS needed to control material and labor expenditures and improve turnaround time and aircraft throughput. This flexible, integrated system easily adapted to the S-3's master data records, but needed to be modified to track components throughout the SDLM cycle. Once accomplished, the Depot worked with the contractor to explore other capabilities of PDMSS to automate shop floor control requirements.

Further enhancements include project planning and scheduling capabilities which are used to provide detailed work plans; work breakdown structures; and resource/facility requirements by phase. NADEP North Island automated the Examination and Evaluation Listing, which lists components for removal. This listing identifies the disposition of each component removed; creates a full route document for components requiring rework; produces material parts requests for damaged/missing components; and tracks changes in disposition of components including back robs. The Depot also set up an S-3 product line "what-if" schedule that shows staffing requirements by trade, facilities requirements, and aircraft master schedules. Other enhancements include automated component installation documentation, component kitting reports, and technical directive compliance records for airframe changes. In the production phase, PDMSS provides aircraft master schedule reports that show baseline plans versus actual performance, as well as various charts, graphs, and other reports. The system also provides charts which track the critical path in the assembly phase by operation. NADEP North Island uses historical data compiled by PDMSS to determine material forecasting, expenditure trends, and workload standard negotiations.

PDMSS is the principal tool for managing productivity and process improvements. Since implementing this system, NADEP North Island reduced the turnaround time of S-3 SDLM from 400 days to 210 days. The Depot plans future improvements for PDMSS, and expects this system to improve productivity and enhance the readiness of the S-3 aircraft.

Appendix A

Table of Acronyms

Acronym	Definition
AC	Activity Coordinator
AMMT	Aviation Maintenance Management Team
APU	Auxiliary Power Unit
CCC	Consolidated Control Center
CPC	Corrosion Prevention Control
DDC	Direct Digital Control
EDAP	Engineering Development Assistance Program
HMDSC	Hazardous Material Distribution Support Center
HMMS	Hazardous Material Management System
IQRS	Individual Qualification Reporting System
ISR	In-Service Repair
MCC	Material Control Center
MSDS	Material Safety Data Sheet
NADEP	Naval Aviation Depot
NAVAIR	Naval Air Systems Command
NIST	National Institute of Standards and Technology
NPSL	Navy Primary Standards Laboratory
PDMSS	Programmed Depot Maintenance Scheduling System
PMB	Plastic Media Blasting
QA	Quality Assurance
SDLM	Standard Depot Level Maintenance
SME	Subject Matter Expert
VIDS	Visual Identification Display System
WIP	Work In Progress

Appendix B

BMP Survey Team

Team Member	Activity	Function
Larry Robertson (812) 854-5336	**Crane Division** **Naval Surface Warfare Center** Crane, IN	**Team Chairman**
Cheri Spencer (301) 403-8100	**BMP Center of Excellence** College Park, MD	**Technical Writer**
	Team 1	
Rick Purcell (301) 403-8100	**BMP Center of Excellence** College Park, MD	**Team Leader**
Jack Tamargo (707) 642-4267	**BMP Satellite Center** Vallejo, CA	
Mike Dobra (909) 273-4618	**Naval Warfare Assessment Station** Corona, CA	
	Team 2	
Larry Halbig (317) 306-3838	**Raytheon Systems Company** Indianapolis, IN	**Team Leader**
Louis Joseph (909) 273-5407	**Naval Warfare Assessment Station** Corona, CA	
Scott Coté (301) 757-0514	**Naval Air Warfare Center** Patuxent River, MD	

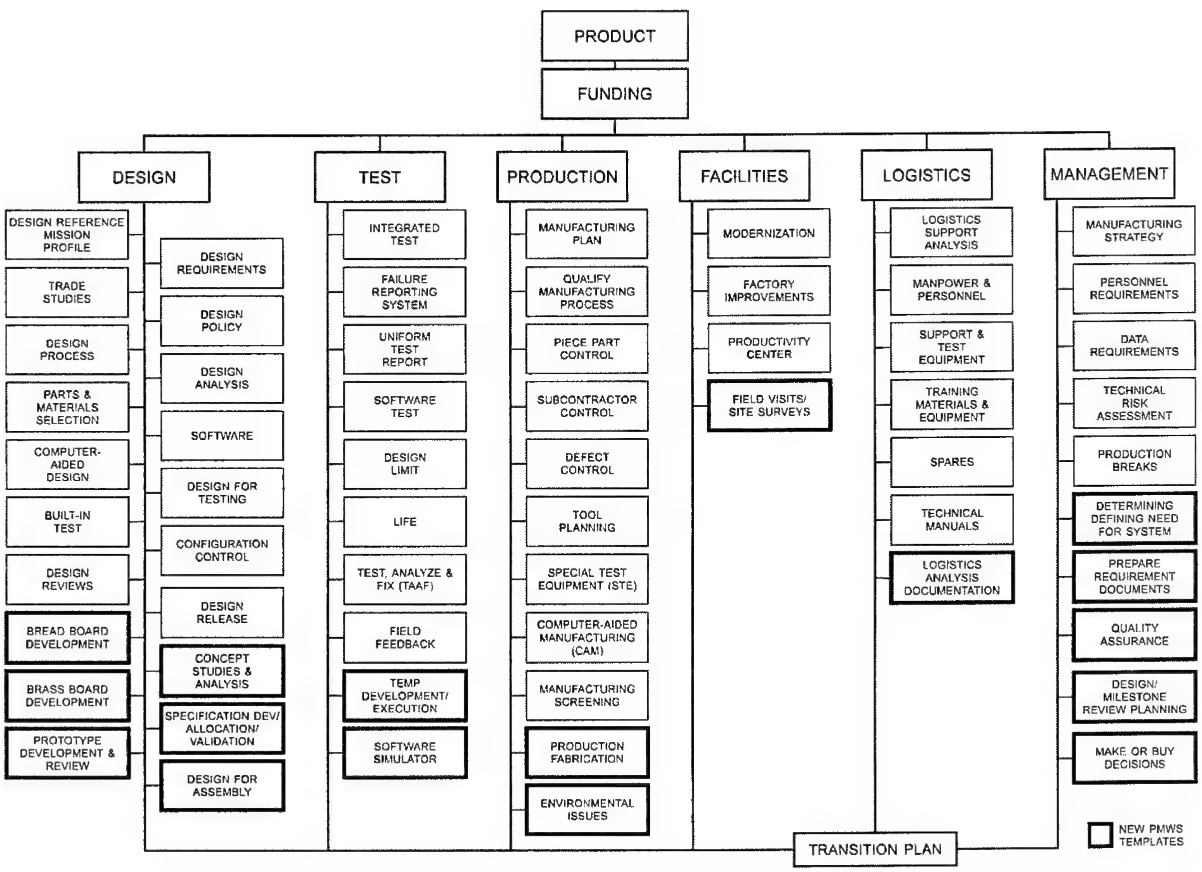
Appendix C

Critical Path Templates and BMP Templates

This survey was structured around and concentrated on the functional areas of design, test, production, facilities, logistics, and management as presented in the Department of Defense 4245.7-M, *Transition from Development to Production* document. This publication defines the proper tools—or templates—that constitute the critical path for a successful material acquisition program. It describes techniques for improving the acquisition process by addressing it as an *industrial* process that focuses on the product's design, test, and production phases which are interrelated and interdependent disciplines.

The BMP program has continued to build on this knowledge base by developing 17 new templates that complement the existing DOD 4245.7-M templates. These BMP templates address new or emerging technologies and processes.

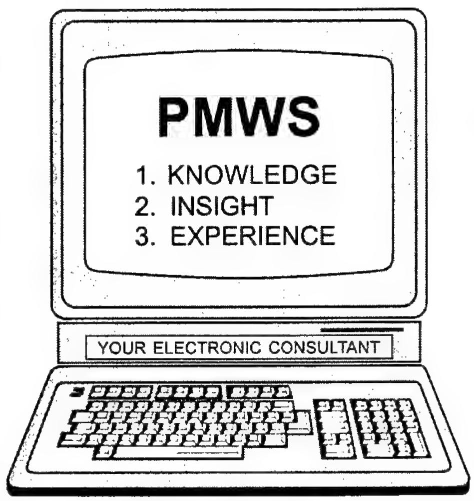
"CRITICAL PATH TEMPLATES FOR TRANSITION FROM DEVELOPMENT TO PRODUCTION"



Appendix D

BMPnet and the Program Manager's WorkStation

The BMPnet, located at the Best Manufacturing Practices Center of Excellence (BMPCOE) in College Park, Maryland, supports several communication features. These features include the Program Manager's WorkStation (**PMWS**), electronic mail and file transfer capabilities, as well as access to Special Interest Groups (SIGs) for specific topic information and communication. The BMPnet can be accessed through the World Wide Web (at http://www.bmpcoe.org), through free software that connects directly over the Internet or through a modem. The PMWS software is also available on CD-ROM.



PMWS provides users with timely acquisition and engineering information through a series of interrelated software environments and knowledge-based packages. The main components of PMWS are KnowHow, SpecRite, the Technical Risk Identification and Mitigation System (TRIMS), and the BMP Database.

KnowHow is an intelligent, automated program that provides rapid access to information through an intelligent search capability. Information currently available in KnowHow handbooks includes Acquisition Streamlining, Non-Development Items, Value Engineering, NAVSO P-6071 (Best Practices Manual), MIL-STD-2167/2168 and the DoD 5000 series documents. KnowHow cuts document search time by 95%, providing critical, user-specific information in under three minutes.

SpecRite is a performance specification generator based on expert knowledge from all uniformed services. This program guides acquisition personnel in creating specifications for their requirements, and is structured for the build/approval process. SpecRite's knowledge-based guidance and assistance structure is modular, flexible, and provides output in MIL-STD 961D format in the form of editable WordPerfect® files.

TRIMS, based on DoD 4245.7-M (the transition templates), NAVSO P-6071, and DoD 5000 event-oriented acquisition, helps the user identify and rank a program's high-risk areas. By helping the user conduct a full range of risk assessments throughout the acquisition process, TRIMS highlights areas where corrective action can be initiated before risks develop into problems. It also helps users track key project documentation from concept through production including goals, responsible personnel, and next action dates for future activities.

The **BMP Database** contains proven best practices from industry, government, and the academic communities. These best practices are in the areas of design, test, production, facilities, management, and logistics. Each practice has been observed, verified, and documented by a team of government experts during BMP surveys.

Access to the BMPnet through dial-in or on Internet requires a special modem program. This program can be obtained by calling the BMPnet Help Desk at (301) 403-8179 or it can be downloaded from the World Wide Web at http://www.bmpcoe.org. To receive a user/e-mail account on the BMPnet, send a request to helpdesk@bmpcoe.org.

Appendix E

Best Manufacturing Practices Satellite Centers

There are currently nine Best Manufacturing Practices (BMP) satellite centers that provide representation for and awareness of the BMP program to regional industry, government and academic institutions. The centers also promote the use of BMP with regional Manufacturing Technology Centers. Regional manufacturers can take advantage of the BMP satellite centers to help resolve problems, as the centers host informative, one-day regional workshops that focus on specific technical issues.

Center representatives also conduct BMP lectures at regional colleges and universities; maintain lists of experts who are potential survey team members; provide team member training; identify regional experts for inclusion in the BMPnet SIG e-mail; and train regional personnel in the use of BMP resources such as the BMPnet.

The nine BMP satellite centers include:

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Appendix F

Navy Manufacturing Technology Centers of Excellence

The Navy Manufacturing Sciences and Technology Program established the following Centers of Excellence (COEs) to provide focal points for the development and technology transfer of new manufacturing processes and equipment in a cooperative environment with industry, academia, and Navy centers and laboratories. These COEs are consortium-structured for industry, academia, and government involvement in developing and implementing technologies. Each COE has a designated point of contact listed below with the individual COE information.

Best Manufacturing Practices Center of Excellence

The Best Manufacturing Practices Center of Excellence (BMPCOE) provides a national resource to identify and promote exemplary manufacturing and business practices and to disseminate this information to the U.S. Industrial Base. The BMPCOE was established by the Navy's BMP program, Department of Commerce's National Institute of Standards and Technology, and the University of Maryland at College Park, Maryland. The BMPCOE improves the use of existing technology, promotes the introduction of improved technologies, and provides non-competitive means to address common problems, and has become a significant factor in countering foreign competition.

Point of Contact:
Mr. Ernie Renner
Best Manufacturing Practices Center of Excellence
4321 Hartwick Road
Suite 400
College Park, MD 20740
(301) 403-8100
FAX: (301) 403-8180
ernie@bmpcoe.org

Center of Excellence for Composites Manufacturing Technology

The Center of Excellence for Composites Manufacturing Technology (CECMT) provides a national resource for the development and dissemination of composites manufacturing technology to defense contractors and subcontractors. The CECMT is managed by the Great Lakes Composites Consortium and represents a collaborative effort among industry, academia, and government to develop, evaluate, demonstrate, and test composites manufacturing technologies. The technical work is problem-driven to reflect current and future Navy needs in the composites industrial community.

Point of Contact:
Mr. James Ray
Center of Excellence for Composites Manufacturing Technology
c/o GLCC, Inc.
103 Trade Zone Drive
Suite 26C
West Columbia, SC 29170
(803) 822-3708
FAX: (803) 822-3710
jrglcc@glcc.org

Electronics Manufacturing Productivity Facility

The Electronics Manufacturing Productivity Facility (EMPF) identifies, develops, and transfers innovative electronics manufacturing processes to domestic firms in support of the manufacture of affordable military systems. The EMPF operates as a consortium comprised of industry, university, and government participants, led by the American Competitiveness Institute under a CRADA with the Navy.

Point of Contact:
Mr. Alan Criswell
Electronics Manufacturing Productivity Facility
One International Plaza
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FAX: (610) 362-1290
criswell@aci-corp.org

National Center for Excellence in Metalworking Technology

The National Center for Excellence in Metalworking Technology (NCEMT) provides a national center for the development, dissemination, and implementation of advanced technologies for metalworking products and processes. The NCEMT, operated by Concurrent Technologies Corporation, helps the

Navy and defense contractors improve manufacturing productivity and part reliability through development, deployment, training, and education for advanced metalworking technologies.

Point of Contact:
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Navy Joining Center

The Navy Joining Center (NJC) is operated by the Edison Welding Institute and provides a national resource for the development of materials joining expertise and the deployment of emerging manufacturing technologies to Navy contractors, subcontractors, and other activities. The NJC works with the Navy to determine and evaluate joining technology requirements and conduct technology development and deployment projects to address these issues.

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Energetics Manufacturing Technology Center

The Energetics Manufacturing Technology Center (EMTC) addresses unique manufacturing processes and problems of the energetics industrial base to ensure the availability of affordable, quality, and safe energetics. The focus of the EMTC is on process technology with a goal of reducing manufacturing costs while improving product quality and reliability. The EMTC also maintains a goal of development and implementation of environmentally benign energetics manufacturing processes.

Point of Contact:
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Institute for Manufacturing and Sustainment Technologies

The Institute for Manufacturing and Sustainment Technologies (iMAST), was formerly known as Manufacturing Science and Advanced Materials Processing Institute. Located at the Pennsylvania State University's Applied Research Labortory, the primary objective of iMAST is to address challenges relative to Navy and Marine Corps weapon system platforms in the areas of mechnical drive transmission techologies, materials science technologies, high energy processing technologies, and repair technology.

Point of Contact:
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National Network for Electro-Optics Manufacturing Technology

The National Netowork for Electro-Optics Manufacturing Technology (NNEOMT), a low overhead virtual organization, is a national consortium of electro-optics industrial companies, universities, and government research centers that share their electro-optics expertise and capabilities through project teams focused on Navy requirements. NNEOMT is managed by the Ben Franklin Technology Center of Western Pennsylvania.

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Gulf Coast Region Maritime Technology Center

The Gulf Coast Region Maritime Technology Center (GCRMTC) is located at the University of New Orleans and focuses primarily on product developments in support of the U.S. shipbuilding industry. A sister site at Lamar University in Orange, Texas focuses on process improvements.

Point of Contact:
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Manufacturing Technology Transfer Center

The focus of the Manufacturing Technology Transfer Center (MTTC) is to implement and integrate defense and commercial technologies and develop a technical assistance network to support the Dual Use Applications Program. MTTC is operated by Innovative Productivity, Inc., in partnership with industry, government, and academia.

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Appendix G

Completed Surveys

As of this publication, 110 surveys have been conducted and published by BMP at the companies listed below. Copies of older survey reports may be obtained through DTIC or by accessing the BMPnet. Requests for copies of recent survey reports or inquiries regarding the BMPnet may be directed to:

Best Manufacturing Practices Program
4321 Hartwick Rd., Suite 400
College Park, MD 20740
Attn: Mr. Ernie Renner, Director
Telephone: 1-800-789-4267
FAX: (301) 403-8180
ernie@bmpcoe.org

1985	Litton Guidance & Control Systems Division - Woodland Hills, CA
1986	Honeywell, Incorporated Undersea Systems Division - Hopkins, MN (Alliant TechSystems, Inc.) Texas Instruments Defense Systems & Electronics Group - Lewisville, TX General Dynamics Pomona Division - Pomona, CA Harris Corporation Government Support Systems Division - Syosset, NY IBM Corporation Federal Systems Division - Owego, NY Control Data Corporation Government Systems Division - Minneapolis, MN
1987	Hughes Aircraft Company Radar Systems Group - Los Angeles, CA ITT Avionics Division - Clifton, NJ Rockwell International Corporation Collins Defense Communications - Cedar Rapids, IA UNISYS Computer Systems Division - St. Paul, MN (Paramax)
1988	Motorola Government Electronics Group - Scottsdale, AZ General Dynamics Fort Worth Division - Fort Worth, TX Texas Instruments Defense Systems & Electronics Group - Dallas, TX Hughes Aircraft Company Missile Systems Group - Tucson, AZ Bell Helicopter Textron, Inc. - Fort Worth, TX Litton Data Systems Division - Van Nuys, CA GTE C^3 Systems Sector - Needham Heights, MA
1989	McDonnell-Douglas Corporation McDonnell Aircraft Company - St. Louis, MO Northrop Corporation Aircraft Division - Hawthorne, CA Litton Applied Technology Division - San Jose, CA Litton Amecom Division - College Park, MD Standard Industries - LaMirada, CA Engineered Circuit Research, Incorporated - Milpitas, CA Teledyne Industries Incorporated Electronics Division - Newbury Park, CA Lockheed Aeronautical Systems Company - Marietta, GA Lockheed Corporation Missile Systems Division - Sunnyvale, CA Westinghouse Electronic Systems Group - Baltimore, MD General Electric Naval & Drive Turbine Systems - Fitchburg, MA Rockwell International Corporation Autonetics Electronics Systems - Anaheim, CA TRICOR Systems, Incorporated - Elgin, IL
1990	Hughes Aircraft Company Ground Systems Group - Fullerton, CA TRW Military Electronics and Avionics Division - San Diego, CA MechTronics of Arizona, Inc. - Phoenix, AZ Boeing Aerospace & Electronics - Corinth, TX Technology Matrix Consortium - Traverse City, MI Textron Lycoming - Stratford, CT

1991	*Resurvey of Litton Guidance & Control Systems Division* - Woodland Hills, CA Norden Systems, Inc. - Norwalk, CT Naval Avionics Center - Indianapolis, IN United Electric Controls - Watertown, MA Kurt Manufacturing Co. - Minneapolis, MN MagneTek Defense Systems - Anaheim, CA Raytheon Missile Systems Division - Andover, MA AT&T Federal Systems Advanced Technologies and AT&T Bell Laboratories - Greensboro, NC and Whippany, NJ *Resurvey of Texas Instruments Defense Systems & Electronics Group* - Lewisville, TX
1992	Tandem Computers - Cupertino, CA Charleston Naval Shipyard - Charleston, SC Conax Florida Corporation - St. Petersburg, FL Texas Instruments Semiconductor Group Military Products - Midland, TX Hewlett-Packard Palo Alto Fabrication Center - Palo Alto, CA Watervliet U.S. Army Arsenal - Watervliet, NY Digital Equipment Company Enclosures Business - Westfield, MA and Maynard, MA Computing Devices International - Minneapolis, MN *(Resurvey of Control Data Corporation Government Systems Division)* Naval Aviation Depot Naval Air Station - Pensacola, FL
1993	NASA Marshall Space Flight Center - Huntsville, AL Naval Aviation Depot Naval Air Station - Jacksonville, FL Department of Energy Oak Ridge Facilities (Operated by Martin Marietta Energy Systems, Inc.) - Oak Ridge, TN McDonnell Douglas Aerospace - Huntington Beach, CA Crane Division Naval Surface Warfare Center - Crane, IN and Louisville, KY Philadelphia Naval Shipyard - Philadelphia, PA R. J. Reynolds Tobacco Company - Winston-Salem, NC Crystal Gateway Marriott Hotel - Arlington, VA Hamilton Standard Electronic Manufacturing Facility - Farmington, CT Alpha Industries, Inc. - Methuen, MA
1994	Harris Semiconductor - Melbourne, FL United Defense, L.P. Ground Systems Division - San Jose, CA Naval Undersea Warfare Center Division Keyport - Keyport, WA Mason & Hanger - Silas Mason Co., Inc. - Middletown, IA Kaiser Electronics - San Jose, CA U.S. Army Combat Systems Test Activity - Aberdeen, MD Stafford County Public Schools - Stafford County, VA
1995	Sandia National Laboratories - Albuquerque, NM Rockwell Defense Electronics Collins Avionics & Communications Division - Cedar Rapids, IA *(Resurvey of Rockwell International Corporation Collins Defense Communications)* Lockheed Martin Electronics & Missiles - Orlando, FL McDonnell Douglas Aerospace (St. Louis) - St. Louis, MO *(Resurvey of McDonnell-Douglas Corporation McDonnell Aircraft Company)* Dayton Parts, Inc. - Harrisburg, PA Wainwright Industries - St. Peters, MO Lockheed Martin Tactical Aircraft Systems - Fort Worth, TX *(Resurvey of General Dynamics Fort Worth Division)* Lockheed Martin Government Electronic Systems - Moorestown, NJ Sacramento Manufacturing and Services Division - Sacramento, CA JLG Industries, Inc. - McConnellsburg, PA
1996	City of Chattanooga - Chattanooga, TN Mason & Hanger Corporation - Pantex Plant - Amarillo, TX Nascote Industries, Inc. - Nashville, IL Weirton Steel Corporation - Weirton, WV NASA Kennedy Space Center - Cape Canaveral, FL Department of Energy, Oak Ridge Operations - Oak Ridge, TN

1997	Headquarters, U.S. Army Industrial Operations Command - Rock Island, IL SAE International and Performance Review Institute - Warrendale, PA Polaroid Corporation - Waltham, MA Cincinnati Milacron, Inc. - Cincinnati, OH Lawrence Livermore National Laboratory - Livermore, CA Sharretts Plating Company, Inc. - Emigsville, PA Thermacore, Inc. - Lancaster, PA Rock Island Arsenal - Rock Island, IL Northrop Grumman Corporation - El Segundo, CA *(Resurvey of Northrop Corporation Aircraft Division)* Letterkenny Army Depot - Chambersburg, PA Elizabethtown College - Elizabethtown, PA Tooele Army Depot - Tooele, UT
1998	United Electric Controls - Watertown, MA Strite Industries Limited - Cambridge, Ontario, Canada Northrop Grumman Corporation - El Segundo, CA Corpus Christi Army Depot - Corpus Christi, TX Anniston Army Depot - Anniston, AL Naval Air Warfare Center, Lakehurst - Lakehurst, NJ Sierra Army Depot - Herlong, CA ITT Industries Aerospace/Communications Division - Fort Wayne, IN Raytheon Missile Systems Company - Tucson, AZ Naval Aviation Depot North Island - San Diego, CA